Research, Development & Technology Division

Quarterly

Missouri Department of Transportation

Vol.3, No. 2

New Resurfacing Technique in District 7

APAC-Missouri Central Division under contract with MoDOT, closed the stretch of U.S. Route 60 in Neosho from new U.S. Route 71 to the Route 175-Route 59-old U.S. Route 71 Junction. The purpose of the road closure, which continued for four weeks was to implement a new resurfacing process on approximately 1.2 miles of U.S. Route 60. This new process is called Ultra Thin (Concrete) Whitetopping (UTW).

This was the first time MoDOT has used Ultra-Thin Whitetopping (UTW). According to Operations Engineer Mark Shelton, former MoDOT director Joe Mickes wanted to determine whether UTW could be a workable alternative to asphalt overlays. Shelton suggested the site for the test. "Route 60 was rutted due to heavy vehicular and truck traffic," said Southern Area Engineer Gary Miller.

UTW is a fibrillated polypropylene-fiber reinforced concrete that is poured no more that six inches in depth. The concrete is applied with no steel reinforcement. "The only strength additive is the fiber," said Neosho Construction Inspector Mike Middleton. "The fiber makes the concrete tougher and helps to hold the concrete together when it cracks."

MoDOT's Research, Development and Technology (RDT) Division began preliminary investigation and material development studies for the use of UTW on U.S. Route 60. RDT worked with the Materials, Design and Construction Divisions to implement this new process. The total cost of the project was approximately $479,000.00 which was funded from MoDOT's contingency fund. "RDT was here extensively throughout the paving process to oversee and run samples for future comparisons and information." said Middleton.

The contractor milled the existing asphalt driving lanes down two inches below the driving surface. The millings were stockpiled at the Neosho maintenance facility for future use. Once the milling was completed, APAC took special care to clean the milled surface because no bonding agent was used. "The actual bond was considerable" Middleton said. "Jackhammers had to be used to remove excess from the header as a loader could not even move the header."

Crew preparing roadway for UTW.

APAC used a slipform concrete paver for most of this process (approximately 90 percent of the job.) Crews used forms and had finishing for the test. APAC slipform paved for 5.03 feet at the full 24 foot wide driving surface. Crews began laying UTW April 19.

According to Middleton, there were some concerns with the UTW paving. These included the texturing of the surface, the rate of application for the curing compound which is sprayed on the surface and the delay in the cutting of the saw joints. The texturizing machine had to delay longer than usual due to the fibers in

(continued on next page)

Inside:

concrete pulling while the texturing lines moved across the surface. The concrete curing compound was applied at a rate one-and-one half times the normal rate of application. This thicker-than-normal application delayed the concrete cutters longer than the standard waiting time before cutting into the pavement.

The joints were cut four feet across the lanes and four foot transverse joints were cut throughout the length of the paving project. The saw joints were cut to a depth of three quarters of an inch. No joint filler was used

Concrete is cut in four by four foot sections.

because the saw joints were only one-eighth of an inch wide and their sole purpose was for crack control. Concrete test cylinders were made to determine whether the concrete was strong enough to withstand heavy traffic. The UTW met the standard when it was only three days old.

Loop detectors which can detect the presence of vehicles through eight inches of concrete were installed at the Lusk Drive intersection and the Route 59-Route 175-old U.S. Route 71 junction.

U.S. Route 60 was opened to through traffic May 11, with the resurfacing completed. APAC Masters Jackson, Springfield Division, placed two inches of asphalt paving on the shoulders and at the Lusk Drive Intersection. The shoulder paving was completed in two days, with two-way traffic running. Joplin's striping crew applied the pavement markings and the signal crew did the signal work.

RDT will monitor this stretch of roadway for sometime to ascertain the strengths or weaknesses of this paving process for future use by MoDOT. "Contractors are willing to work with new processes." Shelton said. "It's nice to see the department trying some of the new technology that is out there.

Thanks to Kim White- District 7- Construction Division

Open House

An Ultra-Thin Whitetopping Open House was held prior to construction to convey project information and review the job site.

Participants included contractors, vendors, local, state, and federal officials. Presentations were made by Research, Development and Technology Division, ACPA-Missouri/Kansas Chapter and District 7 staff.

State	***Location***	***Year Built***	***Size S.Y.***	***Thickness in.***
Missouri	Spirit of St.Louis Airport General Aviation apron, Chesterfield	1994	14,000	3.5
	Helsinki Drive, KCI Airport, Kansas City	1996	2500	2
	Moscow Drive, KCI Airport, Kansas City	1996	2100	2
	39th @ Noland, Independence	1997	1500	3
	Walnut @ Noland, Independence	1998	1557	3.5
	Truman @ Noland, Independence	1998	3873	3.5

Ultra-Thin Whitetopping (UTW):

The State-of-the-Practice for thin Concrete Overlays of Asphalt

Ultra-thin whitetopping (UTW) is a relatively new technique for resurfacing deteriorated asphalt pavements. The process involves placing a very thin layer of concrete, 50 to 100 mm thick, over the old asphalt pavements to form bonded, composite pavements. By bonding the UTW to the existing asphalt surface, the UTW forms a composite pavement section with the underlying asphalt, which reduces the stresses in the concrete layer. The reduction in thickness is justified because the concrete overlay bonds with the existing asphalt pavement to form a thicker, composite section. This composite pavement section delivers the longer life and durable performance characteristics of concrete pavement, yet is cost competitive with an asphalt overlay.

Conventional concrete overlays of asphalt pavements (whitetopping) are a well-established rehabilitation technique. Typically, conventional whitetopping has been used in heavy truck corridors to combat asphalt rutting. These concrete overlays generally have a minimum thickness of 125 mm and are designed assuming no bonding occurs between the existing asphalt and concrete overlay.

Ultra-thin whitetopping differs from conventional whitetopping because specific steps are taken to bond the overlay to the underlying asphalt, and short joint spacings are used. The practice of UTW had been developed specifically for low-volume pavement applications such as city and county roads and intersections, general aviation taxiways and runways, and parking areas. In fact, UTW is a candidate rehabilitation technique for any area where rutting, washboarding, and shoving of the asphalt is a problem. UTW has been shown to withstand the loadings expected on low-volume roads while providing a durable, wearing surface.

How UTW Works:

Three basic factors are required for UTW overlays to perform properly:

●*Archive a bond between the existing asphalt pavement and the UTW.*

●*Provide short joint spacing.*

●*Have an appropriately thick existing asphalt layer.*

Asphalt Bond

Bonding allows the concrete and asphalt layers to perform as a composite section. This causes the two layers to act monolithically and share the load. With bonding, the neutral axis in the concrete shifts from the middle of the concrete down toward the bottom of the concrete. This shifting lowers the stresses at the bottom of the concrete and brings the stresses into a range that the thin concrete can withstand.

The composite section has opposing effects on the corner stress. There is a decrease in the concrete stresses because the whole pavement section is thicker. However, if the neutral axis shifts low enough in the concrete, the critical load location may move from the edge to the corner depending on the materials and layer characteristics. Essentially, the corner stresses decrease because the bonding action creates a thicker section, but increase because the neutral axis shifts down and away from the top surface.

Joint Spacing

To combat this effect, close joint spacing is critical. All pavement types must absorb the energy of the applied load by either bending or deflecting. Traditional concrete pavements are designed to absorb energy by bending and thus are made thick enough to resist stresses induced by bending. With UTW, short joint spacings are used so that energy is absorbed by deflection instead of bending. The short joint spacing also minimizes stresses due to curling and warping by decreasing the amount of slab that can curl or warp.

For the UTW overlays, the short joint spacing in effect forms a mini-paver block system, which transfers loads to the flexible pavement through deflection rather than bending (see Figure 1). Typical joint spacings that have performed well in UTW projects are somewhere between 0.6 and 1.5m/ It is recommended that the maximum joint spacing for UTW be between 12-15 times the slab thickness in each direction. For example, for a 75-mm UTW project, joints should be cut into the concrete at 0.9 to 1.125 m squares.

Asphalt Thickness

When performing a UTW project, there must be enough asphalt to protect the concrete (minimize stresses), and enough concrete must be placed to protect the asphalt (minimize strains). The thicker asphalt pavement section improves the load-carrying capacity of the system because it creates a thicker final UTW pavement structure and carries more of the load. This shifts the neutral axis down in the concrete, which decreases the concrete stresses.

Construction

The construction of a UTW consists of four fundamental steps:

● *Prepare surface by milling and cleaning, or blasting with water or abrasive material.*

● *Place, finish, and cure concrete overlay using conventional techniques and materials.*

● *Cut saw joints early at prescribed spacings.*

A clean surface is required for proper bond. Milling the surface followed by cleaning improves bond because it opens the pore surface of the asphalt pavement. The milling creates a rough surface that “grabs” the concrete and creates the mechanical bond between the two layers. Once a surface is cleaned it is extremely important to keep it clean until paving commences.

Paving a UTW is no different from paving any other concrete pavement. Conventional slip-form and fixed-form pavers, as well as hand-held equipment-such as vibrating screeds—have all been used successfully without major modifications. The only real change is that the concrete layer is thinner than normal. Normal finishing and texturing procedures are applied to the surface.

Proper curing is critical to avoid shrinkage cracking and debonding between the asphalt and pavement. Curing compound should be applied at twice the normal rate. Because the overlay is a thin concrete slab, it has high surface area to volume ratio and can lose water rapidly due to evaporation. Care must also be used during application to avoid spraying curing compound on a prepared surface that would decrease bonding.

Joint sawing should be accomplished with lightweight saws as early as possible to control cracking. Saw depth should be approximately one-fourth to one-third of the total depth of the overlay. Typically, the joints are not sealed. Test studies have shown that UTW pavements perform well without sealants because the compactness of the slabs minimizes joint movement.

The concrete mix selected for a particular project is matched to the traffic conditions and opened-for-traffic requirements. Synthetic fibers are often added to increase the post-crack integrity of the panels.

MoDOT Uses HERMES to inspect bridges

Although it sounds like something out of a really bad science fiction movie, HERMES is not a fictional futuristic satellite that orbits the earth. Would you believe that this odd-sounding piece of equipment is actually operated by the Federal Highway Administration (FHWA) and can help examine bridge surfaces? You better believe it.

Non-destructive Testing

HERMES is actually an acronym for high-speed electromagnetic roadway mapping and evaluation system. The equipment is the only one of its kind and is designed to use electromagnetic waves to detect potential bad spots in bridge surfaces, which will ultimately detect repairs prior to construction. FHWA estimates there are 3.2 billion square feet of bridge deck in the United States, and $1 billion is spent annually on bridge repairs.

MoDOT's St. Louis Metro District was fortunate enough to be able to use this technology to inspect several bridges in the area last month. Bridges on Interstate 44 at 39th Street, Thurman Avenue and Tower Grove Avenue were tested. The testing equipment is located inside a van and takes a "snapshot" of the pavement at speeds of about five miles per hour. The equipment actually utilizes 64 radar antennas to recreate the image inside the bridge deck at a very high resolution. MoDOT engineers hope to discover what condition the asphalt overlay, the bridge deck and the structural steel is in. This will hopefully allow engineers to better plan for the rehabilitation of these bridges, which is scheduled for 2001.

HERMES was used to inspect bridges in the St. Louis area. It is the only one of its kind and is operated by FHWA.

"Missouri is always looking at innovative ways to evaluate the condition or amount of deterioration of some of our bridges scheduled for rehabilitation," said Project Manager Lesley Solinger-Hoffarth.

Bridge Maintenance Engineer Pat Martens said HERMES has the potential of improving bridge evaluations in the future. "The equipment could ultimately detect areas needing bridge repairs and aid in evaluating the condition of the bridge deck," he said. "This could save time and money because we could better estimate the areas in need of repair prior to bidding the project. It could also help us determine if a bridge deck condition has deteriorated to a point requiring replacement."

Now that the data has been collected, FHWA engineers will interpret the findings and report back to MoDOT. The data interpretation process is expected to take several months.

Missouri is only the third state to participate in the testing. The equipment has also been tested in Tennessee and New Jersey. Future testing will take place in Colorado and Minnesota.

MoDOT educates youth on transportation

This year, summer vacation wasn't just swimming pools and movie theaters for 18 minority high school students from the St. Louis area. In fact, this group of ninth and tenth graders spent four weeks looking, listening and learning about the transportation industry.

The teenagers were part of the 1999 Summer Transportation Institute. The program, designed to interest minority high school students in pursuing transportation careers, included leadership and team-building activities, lectures, seminars, hands-on laboratories and field trips.

The students visited MoDOT's highway and bridge projects, central laboratory and sign shop and the Transportation Management Center in Springfield. The Discovery Center in Springfield, houses the Traffic Managementl Center jointly operated by Springfield and MoDOT. One of the construction sites they visited was the extension of Route 179 in Jefferson City, where they observed a dynamic blast. Lincoln University hosted two days of orientation directed toward business issues.

Jim Campbell, MoDOT's Field Materials Director, explains the quality control/ assurance responsibilities of Superpave asphalts.

Tim Chojnacki, Research & Development Engineer with the RDT Division, introduces students to some of the innovative materials that are currently being tested.

A number of MoDOT employees assisted with planning, instruction and field trips. District 6 Senior Highway Designer Stacia Patterson worked with the students on vehicle travel simulations and spoke with them about their experiences during the institute.

"I feel any program like this will broaden young people's knowledge of real world challenges and issues," Patterson said. "The students worked in situations that actually take place, and their eyes were opened to different experiences. The institute is very beneficial to the students and to the department as well.

"The program exposed me to broader points of transportation and how it ties in with engineering," said Russel Anholt, a student participating in the institute. "I may want to pursue a career in engineering."

Josh Morgan, another student, added, "What I liked best were the field trips. I didn't know signs were so big."

MoDOT plans to stay in touch with the students through their high school and college careers and recruit some of them to work for the department.

"We really want to thank all those who helped to plan and participate in the program," said Carol Hurt, Senior Human Resources Specialist, and one of the program's organizers. "They really made everything run smoothly for everyone."

The institute was sponsored by the University of Missouri- Rolla (UMR), the Center for Infrastructure Engineering Studies, the Federal Highway Administration (FHWA), Civitas, Burns & McDonnell, Sverdrup Corporation and MoDOT. It was funded through a grant to UMR from the U.S. Department of Transportation, as well as funds from the university. The advisory board for the program was made up of representatives from UMR, Burns & McDonnell, Rolla High School, Civitas, Sverdrup, MoDOT, FHWA, and Lincoln University.

Each Student received a scholarship that provided funding for tuition, room and board and other expenses. Students had to have completed or been enrolled in Algebra I, a cumulative grade point average of 2.5 and an interest in engineering, science, transportation or a technology based career.

MoDOT's Asst. Chemical Lab Director, Ken Lane gives students an overview of the activities of the Chemical Lab.

For more information on the Summer Transportation Institute, call MoDOT Senior Human Resources Specialist, Carol Hurt at (573) 522-2457.

42nd Annual UMR Asphalt Conference

University of Missouri-Rolla

November 17-18,1999

The 42nd Annual Asphalt Conference will be held on Wednesday and Thursday, November 17-18, 1999, at the University of Missouri-Rolla. Presentations for the conference include:

MoDOT update, MAPA update, meeting PG asphalt grade specifications, segregation, Novachip applications, pavement management systems for local governments, mixing and compaction temperatures, roller temperature sensors, field determination of asphalt content, MAPA design manual, consulting lab experience with Superpave, Superpave for low volume roads, and use of RAP in Superpave.

The conference should be of interest to contractors, public agencies, consulting engineers, testing laboratories, material producers, and equipment manufacturer technical representatives.

For information contact Dr. David N. Richardson, Conference Director, (573) 341-4487 (conference program); or Engineering Continuing Education, Room 105 ME Annex, University of Missouri-Rolla, Rolla, MO 65409-1560, (573) 341-4200 (registration).

Mirror Mounted Pavement Sensors

Description:

The Missouri Department of Transportation (MoDOT) became aware of the importance of pavement temperatures during the SHRP research pertaining to anti-icing practices. In the past, operators have had to depend on the weather forecast, and maintenance building and bank thermometers for their data. These sources provide air temperatures rather than pavement surface temperatures. Our study was to determine if the pavement temperature sensor would be beneficial in identifying the most efficient pavement temperature for applying salt brine or other anti-icing techniques. The RW-1 Roadwatch Infrared sensor was chosen for our study. Laboratory tests prove these units were accurate as advertised ± 1° between 38° F and 5° F. This sensor allowed the operator to observe actual pavement temperatures and trends, and adjust application rates based on real time data. This research unit project placed 50 mirror mounted pavement temperature sensors throughout the state for field use. An additional 125 units have been purchased. They were an immediate success based on operator feedback and district findings.

Advantages / Disadvantages:

Based on the accuracy by the laboratory results and field operator comments, real time pavement temperatures assist the operator in determining proper application rates and times. During the first winter, District One saved $26,946 due to the reduction or elimination of applications that were not appropriate. This translates into $186,469 savings state wide based on each District's salt usage.

The disadvantage to the mirror mounted pavement temperature sensor is it reads what it sees, therefore if the roadway surface becomes covered with snow or ice, it reads the snow or ice in lieu of the pavement temperature. This requires the operator to clear a portion of the pavement so that the accurate pavement temperature can be obtained.

Cost:

The mirror mounted pavement temperature sensors used for the test cost $390 each. The state wide benefit / cost ratio is 9.56 based on a one year life, which will improve as soon as the sensor service life is determined (possibly three to four times greater).

Conclusions:

Districts throughout the state bought an additional 125 units, which indicated the benefits recognized by field personnel. During a recent trip to Champagne, Illinois, we heard a presentation from a snow plow operator from Minnesota DOT on salt solutions. He concluded that the most important addition to the toolbox of a snow plow operator following a plow and spreader is a mirror mounted pavement temperature sensor. We agree with this conclusion. Either by sensor or radio communication, all snow plow operators should have access to real time pavement temperature.

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Missouri Transportation Research Education Center Conference

The second MOTREC Conference was held on June 2, 1999 at the Capitol Plaza Hotel in Jefferson City, MO. The University of Missouri and MoDOT's Missouri Transportation Research Education Center (MOTREC) partnership was identified in the 1998 Peer Exchange as a strength of the RDT Division. The official MOTREC partnership was executed on February 4, 1998. The Peer Exchange also identified opportunities for the division that suggested expanding RDT's communication efforts within MoDOT, expanding roles of employees and advisory committees, soliciting department needs, leveraging university expertise and prioritization of research work. The goal of this conference was to assist in the effort to improve the RDT Division's responsiveness to the department while creating awareness of interest areas to our university partners.

Jim Murray, MoDOT's RDT Division Engineer, opened the conference with a discussion of objectives.

Conference objectives included:

- Open discussion from MoDOT employees to identify research, development and technology transfer needs of the department.
- Share and discuss these needs with staff of the universities.
- Coordinate the department's needs with the research, development and technology expertise of particular universities.

■ Initiate development of technical advisory groups with specific topic areas in preparation of research idea statements, new product evaluations and assistance with prioritizing studies.

Previously identified emphasis areas from the Focus Group meeting were shared with the MOTREC participants. These Focus Group Emphasis Areas included:

■ **Safety**

■ **System Preservation**

■ **Traffic Mobility**

■ **Innovation**

■ **Social, Economic, Environment**

Breakout session topics were established as follows:

Breakout Topics

Bridges

Geotechnical

Operations (Construction and Maintenance practices, products, procedures and system preservation)

Pavements

Traffic (Safety)

Social/Economic/Environment (soft research issues)

From these breakout sessions emphasis items were identified.

A complete summary of emphasis items is available through RDT.

Bridge Emphasis -
(Tim Chojnacki)

■ High Performance Concrete (HPC) applications

■ Seismic Retrofit for Columns

■ High Performance Steel (HPR) applications

■ Fiber Reinforced Polymers (FRP) applications

■ Computerized design program

Geotechnical Emphasis -
(J. D. Wenzlick)

■ GIS Database

■ Erosion Control

■ Pavement Drainage

■ Soil Stabilization

■ Culvert Design

Operations Emphasis -
(Don Davidson)

■ New Products/Processes for positive impact on highways and customers

■ Preventive Maintenance Program

■ Pavement Management System

■ Concrete Joints

■ Shoulder Maintenance

Pavement Emphasis -
(Patty Lemongelli)

■ Life Cycle Cost Analysis (LCCA)

■ Pavement Base and Subbase Stabilization

■ Pavement Smoothness

■ Pavement Recycling Procedures

■ Asphalt Paving

Traffic Emphasis -
(Jim Radmacher)

■ Pavement Markings

■ Safety

■ Geometrics

■ Traffic Division Strategic Plan Addressing

■ Intelligent Transportation System (ITS)

Social, Economic and Environmental Emphasis -
(Keith McGowan)

■ Correlated database information source for project support

■ Research and follow up studies to identify impact of social, economic, and environmental issues

■ Customer Involvement in Transportation Improvement

■ Resources for use in research studies and planning activities

■ Alternative Financing Methods

The Research, Development and Technology Division acknowledges and thanks all the representatives from the department and universities who participated in this MOTREC Conference. This summary of discussion items is intended to keep you informed and involved in the Research, Development and Technology Transfer process of the department. Your comments and suggestions for this division are appreciated.

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The Missouri Transportation Bulletin is published by the Technology Transfer Assistance Program of the Missouri Department of Transportation, Jefferson City, Missouri. The opinions, findings or recommendations expressed in thisBulletin are not necessarily those of MoDOT or the Federal Highway Administration.

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